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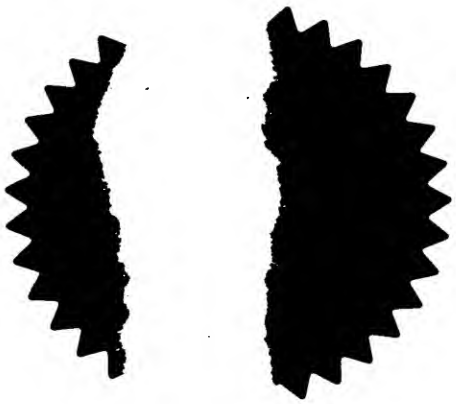

Signed

Dated 22 March 2004

Patents Form 1/77
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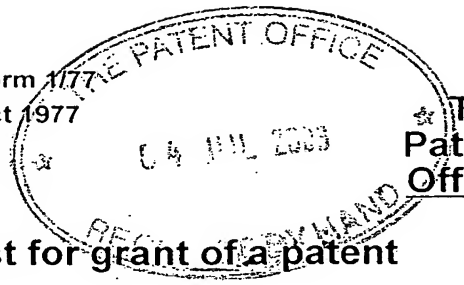


The Patent Office

05JUL03 E820351-7 D02917
P01/7700 0.00-0315738.5

# Request for grant of a patent

The Patent Office
Cardiff Road
Newport
South Wales NP10 8QQ

1. Your reference
**1899001/DJBB**

04 JUL 2003

2. Patent Application Number
0315738.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

**Sensopad Technologies Limited**
**Harston Mill**
**Harston**
**Cambridgeshire**
**CB2 5GG**

Patents ADP number *(if known)*

If the applicant is a corporate body, give the country/state of its incorporation

Country: **ENGLAND**
State:

8157471002

4. Title of the invention

**POSITION ENCODER**

5. Name of agent

**Beresford & Co**

"Address for Service" in the United Kingdom to which all correspondence should be sent

**2/5 Warwick Court**
**High Holborn**
**London WC1R 5DH**

Patents ADP number

1826001

6. Priority details

| Country | Priority application number | Date of filing |
|---|---|---|

## Patents Form 1/77

7. If this application is divided or otherwise derived from an earlier UK application give details

Number of earlier application | Date of filing

8. Is a statement of inventorship and or right to grant of a patent required in support of this request?

YES

9. Enter the number of sheets for any of the following items you are filing with this form.

| | |
|---|---|
| Continuation sheets of this form | |
| Description | **6** |
| Claim(s) | |
| Abstract | |
| Drawing(s) | |

10. If you are also filing any of the following, state how many against each item.

| | |
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| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent *(Patents form 7/77)* | **1 (+ 3 copies)** |
| Request for preliminary examination and search *(Patents Form 9/77)* | |
| Request for Substantive Examination *(Patents Form 10/77)* | |
| Any other documents *(please specify)* | |

11. I/We request the grant of a patent on the basis of this application

Signature Beresford & Co BERESFORD & Co Date 4 July 2003

12. Name and daytime telephone number of person to contact in the United Kingdom **DAVID BRINCK**

Tel: 020 7831 2290

# POSITION ENCODER

## FIELD OF USE

This invention relates to inductive position encoders.

## PRIOR ART

Inductive position encoders are already known from disclosures by the same authors. In particular, inductive position encoders are known which measure the position of an electrical intermediate device relative to a planar arrangement of transmit and receive windings. This relative position is typically given by the EID's position along a plane generally parallel to a cycle of sinusoidally and cosinusoidally wound transmit windings. In such position encoders the transmit windings are typically energised with a pulse width modulated alternating electrical signal. The EID's position is calculated electronically from the phase of the signal received from via the receive windings.

Such position encoders work well in measuring the position of the EID along the windings but are generally incapable of measuring the orthogonal distance of the EID from the plane of the transmit and receive windings.

This invention enables measurement of the EID's orthogonal position relative to the plane of transmit and receive windings.

## THE INVENTION

This invention inductively measures the position of an EID's orthogonal position relative to the plane of transmit and receive windings. When combined with a position encoder of the previously disclosed design, the

combined sensor can measure the position of the EID along the winding pattern as well as its orthogonal position. This combined technique is useful, for example, in measuring the absolute position of multi-turn rotary encoders where the EID rotates within a screw thread. With this invention the sensor is able to measure axial distance travelled and rotation angle. Therefore, absolute angular position can be measured as well as the number of rotational cycles. Such an arrangement is useful in steering wheel encoders for example.

## PREFERRED EMBODIMENT

A diagram showing a section through the centre line of the preferred embodiment is shown in Figure 1.

In a preferred embodiment the EID [6] is a passive LC resonant circuit. Preferably the resonant circuit is made by a capacitor in series with an inductance formed by tracks on a printed circuit board (PCB).

Preferably the transmit [2,3] and receive windings are formed as tracks on various layers of a printed circuit board which may be positioned around a hole through the PCB [1]. The transmit windings are arranged such that a generally sinusoidal field is formed by the first winding [2] and a generally cosinusoidal field formed by the second winding [3]. The field formed by the energised transmit windings is an alternating magnetic field [5] extending along the axis of the windings. The field [5] typically extends further than the windings physical position by a distance substantially equal to the radius of the windings. The

EID's position is measurable within the limits of the field.

The receive winding [4] is also formed as tracks on the same PCB as the transmit windings.

Preferably the windings are embodied as etched copper tracks on an insulating substrate. FR4 type circuit board with plated through holes between the various types of winding are ideally suited to such a construction due to their ease and inexpensive methods of production.

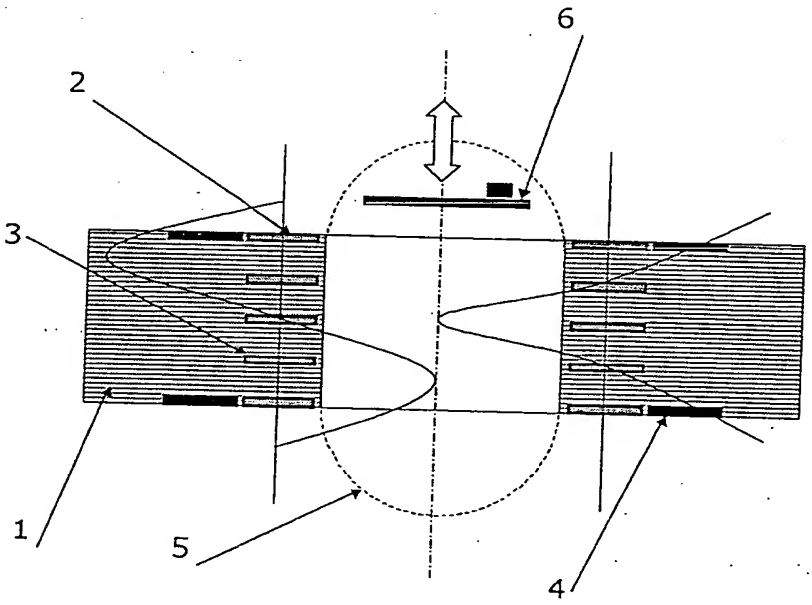


Figure 1

The arrangement of transmit windings is shown in Figure 2. The diagram shows a simplified arrangement for purposes of clarity since the windings preferably comprise multiple turns typically between 1 and 100.

The transmit windings are energised with a pulse width modulated excitation signal where the frequency of

the pulse width modulation is substantially lower than the frequency of the excitation signal. Typically frequencies in the range 10-100 kHz are used for the carrier signal compared to 500kHz - 10MHz for the excitation signal.

The excitation signal is substantially equal to the resonant frequency of the LC resonant EID. The resonant frequency of the EID is preferably in the range of 500kHz to 10MHz.

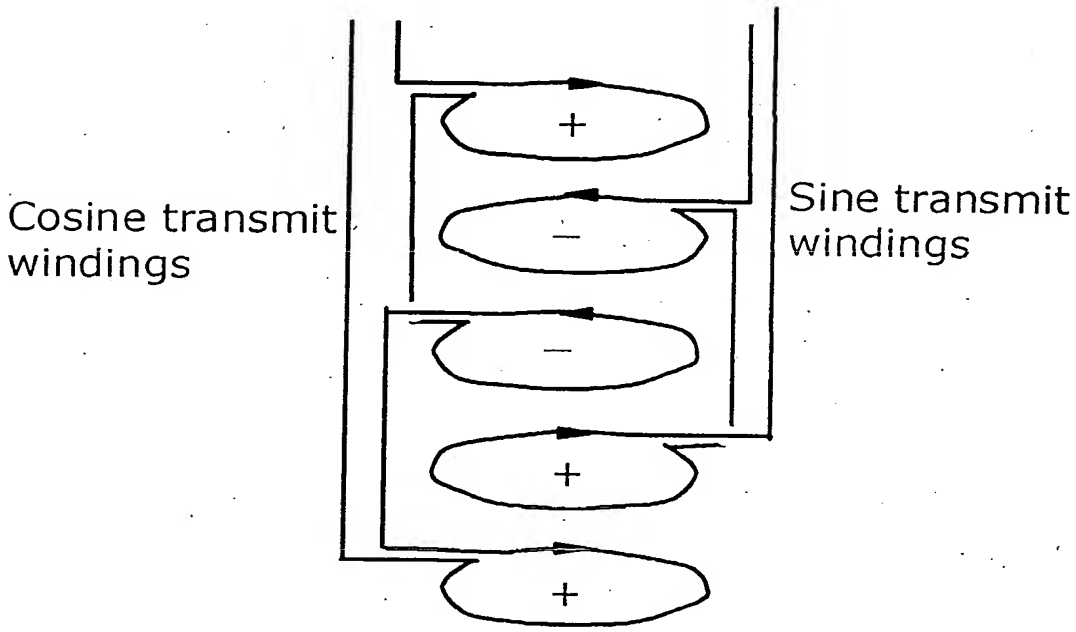


Figure 2

The electronics used to generate the excitation signals, process the receive signals and calculate position is preferably the same as described in the

disclosure Sensing Method & Apparatus by the same authors.

## FURTHER MODIFICATIONS & EMBODIMENTS

A sensor as described above can be combined with the previously disclosed position sensors so that both position along and orthogonal to the windings can be measured. One arrangement of such a combination is shown in Figure 3.

Figure 2 shows one arrangement of such a combination with a second resonant circuit [6b] rotating around and displacing orthogonal to the windings. The rotational sensors two transmit windings [7,8] surround the first position sensor with its receive winding [9] then surrounding the transmit windings.

The windings do not necessarily need to be embodied as tracks on a PCB but may alternatively be wound wire structures or produced by conductive printed ink tracks on an insulating substrate such as Mylar.

Alternatively, rather than an LC resonant circuit the EID may be a permeable element such as a ferrite component or alternatively a metallic component such as a copper, aluminium or steel cylinder. Fasteners such as screws or dowels may also be used as inexpensive and readily available components.

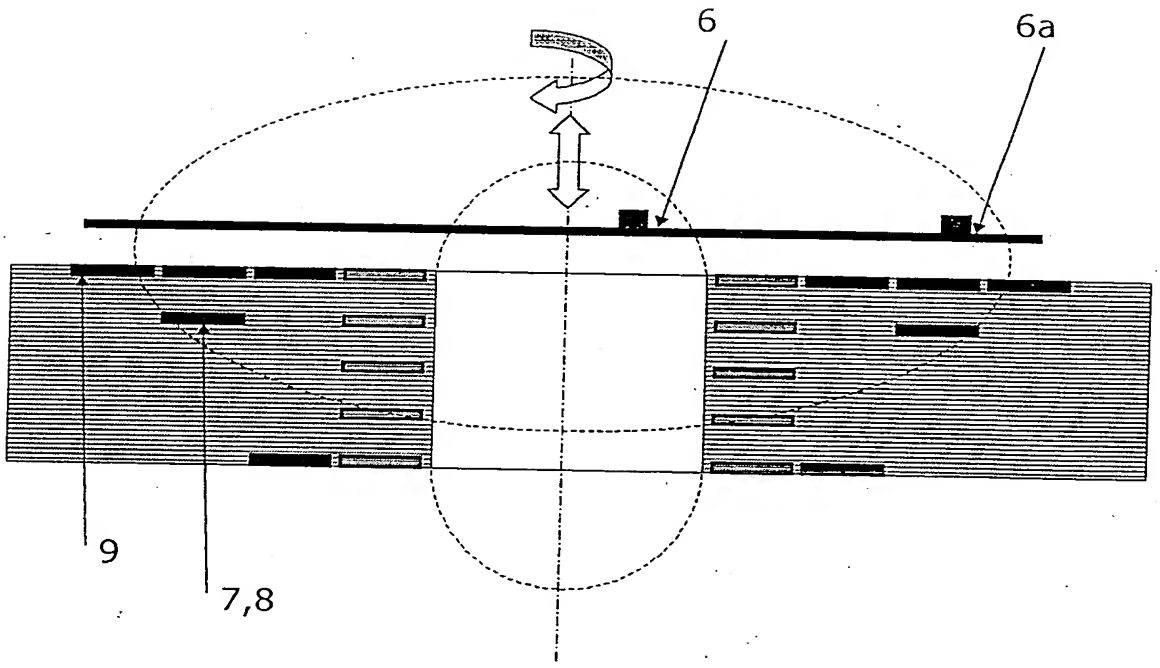


Figure 3